SECTION 20

DECK SLABS

1.20.1 DESIGN CRITERIA

a. The provision of either permanent steel bridge deck forms or conventional removable timber forms shall be accounted for in deck slab designs.

For construction over electrified railroad tracks, permanent steel bridge deck forms shall always be used.

b. To account for the optional use of permanent stay in place (S.I.P.) forms, the deck slab design tables in this Section and in Section 44 of this Manual, assume that an extra 10 millimeter thickness of concrete is added to the dead load of the slab.

When the S.I.P. ribs can not be aligned with the bottom main reinforcement steel, and the forms must be dropped to achieve the 25 millimeter bottom reinforcement cover, Subsection 1.20.3. f., for additional dead load considerations, should be referred to.

Additionally, provision of a 40 millimeter bottom reinforcement cover must be accounted for in bridge structures that are located in a marine environment.

c. Section 3 of this Manual should be referred to for modifications to the AASHTO Standard Specifications for Highway Bridges.

d. A concrete overlay protective system (two-course construction) (see Guide Sheet Plate 3.6-2) is to be used for the design of deck slabs on new bridges or for deck slab replacements in the following categories:

1). All bridges carrying Interstate Highway traffic.

2). All elevated interchange ramps carrying Interstate Highway traffic.

3). Other bridges on the State Highway System with a projected Average Daily Traffic (ADT) count of at least 2000 vehicles and that have a projected Average Daily Truck Traffic (ADTT) that is greater than 5% of an ADT of 2000 vehicles.

Or ***as an alternate*** to the two-course construction, the use of a corrosion inhibitor admixture in a one-course deck is permitted. The use of a corrosion inhibitor admixture shall conform to the requirements of Subsection 501.12, Subpart 19 of the NJDOT Standard Specifications for Road and Bridge Construction.
Plan notes to permit the alternative one-course full depth deck slab, with a corrosion inhibitor admixture as part of the concrete design mix, shall be provided. A Section View of the one-course deck slab shall also be

provided. This view should detail a 72 millimeter minimum top reinforcement cover.

The construction documents should be finalized on the assumption that a two-course deck slab will be constructed.

e. A one-course concrete deck slab construction (see Guide Sheet Plate 3.6-1) is to be used for the design of deck slabs on new bridges which are not included in the categories listed in d. above.

f. If any of the bridges in the categories listed under paragraph d. above are located in areas of significant adverse geometrics (see Subsection 1.20.7), which could preclude machine finishing of the concrete overlay protective system course, then the deck slab should be designed on the basis of a one-course construction.

Opinions from construction forces regarding machine finishing capabilities in such cases are warranted.

g. Thirteen millimeters shall be deducted from the actual deck slab thickness in the design calculations for one course slabs as an allowance for depth of sawcut grooved finishing and wear.

The superstructure design for bridges with one course deck slabs shall include a 1.2 kPa provision for a future 50 millimeter thick concrete overlay protective system.

h. In two-course deck slabs, the concrete overlay protective system course is to be considered as part of the structural slab in the design calculations but 13 millimeters shall be deducted from the total thickness of the two courses as an allowance for depth of sawcut grooved finishing and wear.

Assume that the effective slab depth is taken from the bottom of the slab to the center of the top main reinforcement steel.

Bridges with two-course deck slabs shall not include a 1.2 kPa additional dead load for the superstructure design.

1.20.2 CORROSION PROTECTED REINFORCEMENT IN DECK SLABS

a. All concrete deck slab reinforcement steel shall be corrosion protected. When epoxy coated reinforcement is planned, the top and bottom layers of rebars in structural deck slabs shall be epoxy coated. These bars include transverse bars, longitudinal distribution bars, corner, skew and header bars.
In culverts where the top slab is used as a roadway riding surface, the top layer of rebars shall be corrosion protected.

b. When galvanized reinforcement is considered, both the top and bottom

mat layers shall be galvanized. In addition, chairs, tie wires, nuts, bolts, washers, other devices and miscellaneous hardware that is to be used to support, position or fasten the galvanized reinforcement shall be galvanized. Plastic chairs or plastic coated metal hardware, in lieu of galvanized components, may be used.

c. When a bridge is located in a severe marine environment (Zone 3B, see Subsection 1.24.18, Paragraph (e)), cover for the bottom rebars shall be 40 millimeters instead of the 25 millimeters normally specified.

d. The Designer shall designate the use of epoxy coated reinforcement or galvanized reinforcement in the deck slab construction.

1.20.3 THICKNESS AND REINFORCEMENT STEEL

a. See Guide Sheet Plates 3.6-1 and 3.6-2 for typical deck slab reinforcement details.

b. The table on the next page, for one-course construction based on 65 millimeter top cover, 25 millimeter bottom cover, and rebars perpendicular to traffic with f_c = 9.8 megapascals and f_s = 165 megapascals, has been prepared in order to establish uniformity in design and details. However, the Designer shall develop the design of deck slabs for each bridge and the calculations shall be included in the design folder.

ONE-COURSE CONSTRUCTION FOR DESIGN LIVE LOADING MS18 +25%		

EFFECTIVE SLAB SPAN (S)	SLAB THICKNESS (Actual)	REINFORCEMENT STEEL (TOP & BOTTOM)
1.22 m to 1.36 m	215 mm	#16 @ 200 mm
Over 1.36 m to 1.59 m	215 mm	#16 @ 175 mm
Over 1.59 m to 1.76 m	215 mm	#19 @ 225 mm
Over 1.76 m to 1.97 m	215 mm	#19 @ 175 mm
Over 1.97 m to 2.08 m	215 mm	#19 @ 150 mm
Over 2.08 m to 2.22 m	220 mm	#19 @ 150 mm
Over 2.22 m to 2.36 m	225 mm	#19 @ 150 mm
Over 2.36 m to 2.49 m	230 mm	#19 @ 150 mm
Over 2.49 m to 2.63 m	235 mm	#19 @ 150 mm
Over 2.63 m to 2.76 m	240 mm	#19 @ 150 mm
Over 2.76 m to 2.90 m	245 mm	#19 @ 150 mm
Over 2.90 m to 3.03 m	250 mm	#19 @ 150 mm
Over 3.03 m to 3.16 m	255 mm	#19 @ 150 mm
Over 3.16 m to 3.29 m	260 mm	#19 @ 150 mm
Over 3.29 m to 3.36 m	265 mm	#19 @ 150 mm

The following table, for two-course construction based on 40 millimeter top cover on the first course, 25 millimeter bottom cover, and rebars perpendicular to traffic with f_c = 9.8 megapascals and f_s = 165 megapascals, has been prepared in order to establish uniformity in design and details. However, the designer shall develop the design of a

deck slab for each bridge and the calculations shall be included in the design folder.

TWO-COURSE CONSTRUCTION FOR DESIGN LIVE LOADING MS18 + 25%			
EFFECTIVE SLAB SPAN (S)	ACTUAL SLAB THICKNESS (FIRST COURSE)	REINFORCEMENT STEEL (TOP & BOTTOM)	TOTAL THICKNESS WITH 32mm CONCRETE OVERLAY
1.22 m to 1.35 m	190 mm	#16 @ 200 mm	222 mm
1.36 m to 1.59 m	190 mm	#16 @ 175 mm	222 mm
1.60 m to 1.86 m	190 mm	#19 @ 225 mm	222 mm
1.87 m to 2.08 m	190 mm	#19 @ 175 mm	222 mm
2.09 m to 2.20 m	190 mm	#19 @ 150 mm	222 mm
2.21 m to 2.35 m	195 mm	#19 @ 150 mm	227 mm
2.36 m to 2.50 m	200 mm	#19 @ 150 mm	232 mm
2.51 m to 2.65 m	205 mm	#19 @ 150 mm	237 mm
2.66 m to 2.79 m	210 mm	#19 @ 150 mm	242 mm
2.80 m to 2.94 m	215 mm	#19 @ 150 mm	247 mm
2.95 m to 3.09 m	220 mm	#19 @ 150 mm	252 mm
3.10 m to 3.23 m	225 mm	#19 @ 150 mm	257 mm
3.24 m to 3.35 m	230 mm	#19 @ 150 mm	262 mm

c. The selection of beam spacings cannot be standardized since they depend on beam type. Generally, beam spacings of 2.4 to 3 meters are preferred. The basis for the selection of beam spacings shall include consideration of the necessity of future deck replacement and the maintenance of traffic associated with a deck replacement.

d. The main reinforcement shall be placed normal to the stringers regardless

of the skew of the deck slabs. The bars shall be straight, continuous, and of the same size and spacing in top and bottom of slab. Reinforcement shall be #16 or #19 bars with a minimum spacing of 150 millimeters.

The spacing of S.I.P. form ribs shall match the spacing of the main bottom reinforcement steel (see Guide Sheet Plate 3.6-10). Situations in which this requirement may be waived are listed in part f. below.

Designers should locate stud shear connectors to avoid conflicts with the main bottom reinforcement spacing. This is due to the fact that there is little room for field adjustment when the main reinforcement steel must match the rib spacing. Shop drawings for S.I.P. forms should be checked accordingly.

e. For continuous beam spans additional epoxy coated or galvanized longitudinal bars shall be provided over the interior supports. Refer to Subsection 1.20.2 for guidance in the required placement of reinforcement steel. The reinforcement shall be designed in accordance with AASHTO Article 10.38.4.3.

The additional reinforcement bars shall be located between the distribution bars. In accordance with AASHTO Article 10.38.4.4., the additional longitudinal reinforcement bars shall be extended into the positive moment region that is beyond the anchorage connectors

f. The main reinforcement pattern in the acute corners of skewed slabs and in the deck slabs of curved girder bridges shall be given special consideration. In the acute corners of skewed slabs, some of the main reinforcement may have to be placed in a fanned arrangement extending into the corner of the deck slab. On curved girder bridges, the main reinforcement is generally placed radially.

If it is anticipated that, in lieu of timber forms, S.I.P. forms will be utilized, and the main reinforcement will not be aligned with the S.I.P. ribs, a 25 millimeter thickness of concrete shall be added to the dead load of the slab. This is in lieu of the 10 millimeter thickness of concrete that is specified in Subsection 1.20.1 b.

This extra 15 millimeter thickness of concrete will account for the additional dead load that results from dropping the S.I.P. forms.

Dropping the forms is needed to achieve the minimum 25 millimeter rebar cover and assumes a 50 millimeter nominal form depth. Deeper forms will require additional dead load consideration.

When the extra dead load is added, the Tables within this Section and in Section 44 are no longer valid. The designer shall develop an independent slab design. The shop drawings shall be checked carefully to verify that the intended result is acceptable.

g. In deck slab corners where the acute angle is 65E or less, 7-#16 bars by 4.5 meters long shall be placed directly under the top layer of bars. They should be detailed in a fanned arrangement. This reinforcement shall also be corrosion protected; such as, epoxy coated or galvanized.

1.20.4 DECK JOINTS

a. Refer to Section 21 for the design of transverse and longitudinal joints in deck slabs.

b. Shear locks, as specified in Subsection 1.24.15 of this Manual, shall be provided with the structural steel work when a longitudinal expansion joint is located in the roadway area.

c. See Guide Sheet Plates 3.8-1 and 3.8-2 for details of longitudinal joints.

1.20.5 HAUNCHES ON STRINGER BRIDGES

a. All steel stringer bridges with monolithic deck slabs shall be provided with a haunch over each stringer that is monolithic with the slab. The minimum depth of haunch shall be 25 millimeters at the centerline of the span. This is as measured from the top of the steel flange to the theoretical bottom of the slab at the center of the web. A deeper haunch may be required when the top flange exceeds 400 millimeters in width. This is to allow for deck slab cross slopes.

b. The minimum haunch dimension shall be calculated to include all factors such as roadway profile, architectural camber, camber for future overlay, camber for future utilities, deck cross slopes, etc.

c. For simple span welded steel girder bridges, the depth of the haunch at the centerline of bearings shall be the minimum depth, that is computed in b. above, plus the difference in thickness between the maximum and minimum top flange plates.

d. Haunches of fascia beams of multispan bridges shall be set so that the top of the webs of fascia beams in adjacent spans line up.

e. The depth of the haunches shall be labeled on the plans only at the center line of bearings. The depth of the haunch at the centerline of bearing is necessary on the plans to enable the contractor to verify the concrete seat elevations. The depth of the haunch at other locations along the span will be computed by the Contractor after the superstructure steel has been erected.

f. Haunches to a maximum of 100 millimeters shall be reinforced with U-stirrups. The minimum reinforcement shall be #16 stirrups at 300 millimeters.

g. Where field splices in the stringers are shown on the plans or permitted in

the Specifications, the haunch shall be a minimum depth of 25 millimeters over the splice plate. A 25 millimeter minimum clear cover shall be maintained between the main steel reinforcement and the bolts.

1.20.6 CONCRETE PLACING SEQUENCE

a. A concrete deck slab placing sequence shall be shown on the plans for deck slabs supported by trusses, arches, continuous and cantilevered design. Other types of structures may also require special deck placement sequences such as single span curved girder bridges.

b. Details of the transverse construction joints for the deck placing sequence should be developed and shown on the plans. The joint shall be keyed and the entire face of the joint shall be coated with an approved epoxy bonding compound. Refer to Subsection 518.04 Subpart 2. a. of the NJDOT Standard Specifications for proper use of the epoxy bonding compound.

Designing the construction joint as an edge beam should be considered. For skewed spans, a skewed-stepped arrangement may be required because of the use of permanent steel stay in place forms.

c. In the construction of Integral Abutment deck slabs, if girder continuity is provided, a deck placing sequence should be detailed for spans greater than 30 meters.

1.20.7 MACHINE FINISHING

a. It shall be the responsibility of the Structural Design Engineer to show the following note on deck slab plans where conditions could conceivably preclude the use of machine finishing:

NOTE: Machine finishing of deck slab not required.

The following criteria could preclude the use of machine finishing of bridge deck slabs:

1). The bridge is on a curve of less than 76 meter radius.

2). The acute skew angle is less that 40 degrees.

3). The cross slope is variable.

4). Variable width occurs with non-parallel machine support rails.

5). Variable width is due to internal variable width lane with grade breaks at the edges of this lane.

6). Only one structure is in the contract and/or the length is less than

18.2 meters and curb to curb distance is 7.2 meters or less.

7). Staging of construction is such that machine finisher overhang will interfere with active vehicular traffic lanes.

b. The construction industry may develop more sophisticated machines and techniques that could overcome the above adverse criteria; consequently, a final review shall be made to determine if the note is applicable depending on the state of the art at the time of advertising for bids.

c. It is generally accepted that finishing machines produce more durable and better quality decks. Therefore, Highway and Bridge Designers shall make every effort to eliminate adverse geometrics from bridge decks during design phases so that finishing machines may be used.

d. After finishing has been completed, the surface of the deck slab shall be textured with an artificial turf drag. Material requirements for the turf drag are given in Subsection 501.15 of the Standard Specifications. The drag shall be operated in the transverse or longitudinal direction and inaccessible areas shall be textured by hand methods.

e. When the concrete or concrete overlay protective system on the deck surface has cured for a minimum of 14 days and has reached a strength of at least 28 megapascals, transverse grooves shall be sawcut into the surface of the bridge deck. Requirements for the sawcutting operation are given in Subsection 501.15 of the Standard Specifications.

f. Grooving of skewed bridge decks shall not be overlapped. Grooving passes on curved decks shall be made radial to the center of the curve with ungrooved gores at the outside of the curve. If the curve is such that the width of the gores exceed 100 millimeters, the first pass of the grooving machine shall be normal to the center line of the span at midspan with subsequent passes parallel to the initial pass.

1.20.8 APPROACH SLABS

a. Approach and transition slabs are required for all bridges on the State Highway System. This shall also apply to the reconstruction of such bridges.

b. For bridge structures not on the State Highway System, if the following conditions exist, provision of approach and transition slabs will not be considered.

1.) When the projected Average Daily Traffic (ADT) is less than 2000 vehicles.

2.) When the Average Daily Truck Traffic (ADTT) is less than 5% of the ADT.

c. For bridge widening or rehabilitation projects; such as, installation of a concrete overlay protective system, provision of approach slab and transition slabs shall be subject to the approval of the Manager, Structural Engineering.

1.20.9 MEDIANS

a. Unless precluded by profile and geometric considerations, the median area between parallel bridges shall be “decked over” when the width between curb lines is 9 meters or less. See Guide Sheet Plate 3.6-4.

b. When the median width is greater than 9 meters, cost estimates shall be made for the alternative of “decking over” vs. ”open well design”.

c. Decking over is preferred in all cases for safety reasons when the extra construction cost is relatively insignificant.

d. Live load design for the median area shall also be MS18+25% (MS22.5).

e. Medians on bridges which are designated for two course slab construction shall also be designed for a two course construction. A sawcut in the texture finish for the second course will not be required in the median area (use float finish). The Project Special Provisions should address this condition.

1.20.10 PARAPETS, BARRIERS AND SIDEWALKS

a. Provide 5 millimeter open deflection joints in parapets at intervals not exceeding 6 meters. Contraction joints at the midpoint between the open joints shall also be provided (see Bridge Construction Detail BCD - 3).

b. Contraction joints shall be provided in sidewalks at the locations of the 5 millimeter open parapet deflection joints (see Bridge Construction Detail BCD - 3).

c. Provide 5 millimeter open deflection joints in median barriers at intervals not exceeding 4.5 meters. There shall be no contraction joints between the open joints and no contraction joints located below the open deflection joints (refer to Bridge Construction Detail BCD-4).

d. Full depth joints shall be provided in parapets, median barriers and sidewalks at locations of transverse deck joints. The full depth joint opening width shall equal the transverse deck joint opening width.

e. All reinforcing steel in parapets, median barriers and sidewalks shall be corrosion protected; such as, epoxy coated or galvanized.

f. Refer to Bridge Construction Detail (BCD-3) for additional reinforcement that is required to prevent concrete cracking in the overhang portion of the deck slab.

1.20.11 DECK SLAB OVERLAY PROTECTIVE SYSTEMS

a. Provision of a deck slab overlay protective system shall conform to the requirements of Subsection 518.06 of the NJDOT Standard Specifications for Road and Bridge Construction.

b. Provision of bituminous concrete overlays on bridge deck slabs is not permitted.